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TO U. S. NAVAL RADIOLOGICAL
DEFENSE LABORATORY
TECHNICAL REPORTS (TR Series)

Issued from 1 July 1961 through 31 December 1962

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TECHNICAL INFORMATION DIVISION
T. J. Mathews, Head

AVAILABILITY OF USNRDL TR'S

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Eugene P. Cooper
Eugene P. Cooper
Scientific Director

E. B. Roth
E. B. Roth, CAPT USN
Commanding Officer and Director

PREFACE

This volume contains a numerical compilation of abstracts of Technical Reports (USNRDL-TR series) published by the U. S. Naval Radiological Defense Laboratory during the period 1 July 1961 through 31 December 1962. This volume supplements USNRDL-463, USNRDL-465, and USNRDL-470 as a continuation of the index of Technical Reports issued by the Laboratory; the index series includes information concerning all TR's published from 15 September 1953 to 31 December 1962. Each abstract is accompanied by its TR number, title, author(s), date of publication, and current classification. Classified material has been edited from the abstracts and titles of classified reports. The volume is UNCLASSIFIED. The Laboratory will continue to bring the index series up to date by the publication of current supplements.

For a listing of TR abstracts appearing in the Atomic Energy Commission journals entitled Nuclear Science Abstracts (NSA) (UNCLASSIFIED) and Abstracts of Classified Reports (ACR) (CLASSIFIED), see Subject Index entry "Reports (USNRDL-TR)."

In the Subject Index, entries list the report number, which may then be found in numerical order. Various divisional categories have been added in order to aid in the identification of material contained in the documents.

The Author Index lists all reports in which each author collaborated. The Division-Author Index indicates all documents issued by a specific division, together with their individual authors.

USNRDL-TR-519

INCREASED RADIRESISTANCE IN MICE INJECTED WITH
URETHANE TWO DAYS BEFORE X IRRADIATION

L. J. Cole and S. R. Gospe
10 July 1961 25 p. UNCLASSIFIED

Rosin and Goldhaber (Blood 11:1032, 1956) reported a rise in mitotic index of bone marrow and a relative increase in myeloid precursors following repeated injections of urethane into mice. These findings suggested the possibility of altering radiosensitivity of mice by this agent. Adult female (C57LxA)F₁ mice received two intraperitoneal injections of an aqueous solution of urethane (1 mg/g body wt), one day apart. Twenty-four hours after the last injection, the mice were exposed to a single acute dose of 250 kvp X rays, in the middlethal or lethal range. The 30-day LD₅₀ for the urethane-treated mice was found to be 970 r; the LD₁₀₀ was 1010 r. The corresponding values for the control irradiated mice were 790 r and 840 r, respectively. The radioprotective effect of urethane was not seen when the drug was administered 30 minutes before irradiation, nor when the mice were irradiated 7 days after the last urethane injection. The protective effect could not be duplicated by preradiation exposure (1 or 2 days prior) to 100 r, 200 r, or 300 r. Nonirradiated mice given two daily injections of urethane as described above, exhibited a marked fall within 24 hours in the total nucleated cell count of femoral marrow and peripheral blood, accompanied by a definite increase in the myeloid/lymphoid cell ratio of the blood. The results suggest that urethane-induced alterations in cell population of bone marrow are accompanied by an increase in the number of relatively radioresistant cell types involved in myelopoiesis.

USNRDL-TR-520

THE NON-SPECIFIC ACCEPTANCE OF SKIN TRANSPLANTS BY
RADIATION CHIMERAS

M. S. Silverman
10 July 1961 22 p. UNCLASSIFIED

The immunological status of lethally irradiated mice protected against the acute effects of irradiation by the transfusion of rat or allelogenic, parental or isogenic bone marrow was studied using the reaction against skin grafts as the indicator system. The data indicated that the radiation chimeras were immunologically unresponsive animals and were, therefore, able temporarily to accept skin grafts from donors foreign to both the irradiated host and the marrow donor. It was concluded that the ultimate rejection of the skin grafts was the result of the recovery of the host's immune response rather than the result of any contribution of donor marrow cells to the immune system. If the animal survives, a specific tolerance towards the bone marrow donor's skin may develop. A possible alternative hypothesis to explain the persistence of the foreign skin grafts despite deaths from "secondary disease" is discussed.

USNRDL-TR-522

RADIOCHEMICAL DETERMINATION OF SODIUM-24 AND
SULFUR-35 IN SEA WATER

D. Love and D. Sam
10 July 1961 27 p. UNCLASSIFIED

Rapid radiochemical procedures were developed for determining Na^{24} and S^{35} in sea water containing fission product radionuclides. Na^{24} is separated from other radionuclides by scavenging with lanthanum hydroxide; two sodium chloride precipitations with hydrogen chloride gas follow. The disintegration rate is determined by measuring the area of the 1.368 Mev gamma photopeak. The working time required for a single analysis is 1/2 hr; the precision, ± 1 percent; the chemical yield, about 70 percent; and the total effective decontamination factor from fission products, $>>10^5$.

S^{35} in sea water is separated from other radionuclides through precipitating barium sulfate. This is followed by reducing the sulfate to hydrogen sulfide with hydrogen iodide and by subsequently oxidizing sulfide to sulfate in an alkaline peroxide solution. The resulting sulfate ion is precipitated as barium sulfate for chemical yield determination and counting. The working time required for a single analysis is less than 1 hr; the precision, ± 5 percent; the chemical yield, 70-80 percent; and the decontamination factor from fission products, $>10^7$.

Although the samples tested are salt solutions contaminated with fission products, as in the case of nuclear explosions in the ocean and in salt domes, these methods are applicable to many other types of samples containing fission products and induced activities.

USNRDL-TR-523

THE RGI-20 RADIAC SYSTEM — A WIDE-RANGE BETA-GAMMA INSTRUMENT

PART I SURVEY METER SKIN-DOSE PROBE

K. Miller and G. T. Kiyoi
7 September 1961 36 p. UNCLASSIFIED

A wide-range, multipurpose radiac of 20 percent accuracy has been developed for tactical military use.

The instrument consists of a 2 1/2-lb, belt-carried package which measures gamma rate in three ranges to 1,000 rad/hr, and a "plug-in" probe to read skin-dose rate (beta + gamma) to 5,000 rad/hr. Provision is made to connect a four-decade low-range probe now under development, or to connect other special purpose detectors remote from the meter.

The RGI-20 incorporates several other features unusual in Navy radiacs: a recycling ion chamber and low-impedance circuitry, a simplified scale-changing mechanism capable of switching 11 linear scales, and rechargeable batteries.

This report presents construction and performance information.

USNRDL-TR-524

RESPONSE REQUIREMENTS FOR MILITARY RADIACS
I. THE EFFECTS OF ARCTIC CONDITIONS ON THE PERFORMANCE OF NAVY RADIACS

W. E. Knight, D. H. Williams, H. R. Wasson
29 August 1961 36 p. UNCLASSIFIED

A survey of the nature of arctic operating conditions was conducted to determine the factors important to radiacs. The results of the survey are summarized for application in radiac design. Under simulated arctic conditions involving low temperature and wind velocity, the two latest Navy gamma radiacs operate within the \pm 20 percent required accuracy for about 2 hr at -40°C . Simple thermal-insulating wraps extend the time about 1 hr. Alkaline manganese dry cells (type E95) substituted for BA-30 carbon-zinc cells render the radiacs virtually indifferent to temperatures as low as -40°C . Vibration at -40°C with type E95 had no deleterious effect. It was shown that operation of unmodified radiacs for a few hours is possible under arctic conditions if certain precautions are taken. If longer continuous operation is required, thermal insulation or change of battery type is necessary.

USNRDL-TR-525

RADIATION INSTRUMENTATION FOR THE CLASSIFICATION OF
NUCLEAR EXPLOSIONS AT SEA

E. J. Wesley
7 September 1961 53 p. UNCLASSIFIED

The report is a survey of the measurement problems, environment and instrumentation requirements for the detection and sampling of clandestine nuclear explosion debris at sea. The survey is oriented toward the problems of a search team policing a world nuclear test ban and recommends improvement of existing water proving devices and development of a ship-to-water survey system and expendable depth probes. The depth probes would explode a charge on contact with submerged radioactive pools and this signal would be monitored by the ship's sonar.

USNRDL- TR-526

FATTY ACID METABOLISM IN RAT INTESTINAL SEGMENTS

D. Porte and C. Entenman

21 September 1961 42 p. UNCLASSIFIED

An *in vitro* preparation of rat intestinal segments capable of incorporating, esterifying, and oxidizing fatty acids is presented. After appropriate selection of tissue segments, reproducibility is excellent. With this preparation, three separate reactions have been studied; esterification, oxidation, and incorporation of fatty acid. Esterification required glucose and oxygen but was insensitive to insulin. Succinate did not substitute for glucose. Oxidation and esterification were depressed by succinate, fluoride, and arsenate. Oxidation was not influenced by glucose. Incorporation followed the kinetics of a first order reaction at any albumin concentration. It was also found to be a reversible reaction, independent of cellular energy production. The implications of the reversible nature of the reaction have been discussed with reference to a reinterpretation of the source of plasma FFA. Sodium taurocholate in high concentration accelerated incorporation, but not esterification, as has been previously reported.

USNRDL- TR-527

QUANTITATIVE RADIOCHEMICAL ANALYSIS- SOLVENT EXTRACTION OF MOLYBDENUM-99

L. Wish

12 September 1961 17 p. UNCLASSIFIED

A method has been developed for the rapid quantitative separation of molybdenum-99 from fission product mixtures. It is based on the extraction of molybdenum into a solution of α -benzoin oxime in chloroform. The main contaminants are zirconium, niobium and iodine. The first two are eliminated by complexing with fluoride and the third by volatilization or solvent extraction. About 5 percent of the technetium-99 daughter is extracted with its parent, and it is necessary to wait 48 hours for equilibrium to obtain an accurate gamma ray counting result. The analysis of fission product mixtures by this method

and a standard radiochemical gravimetric procedure showed agreement within 1-2 percent.

USNRDL- TR- 528

EARLY TIME DECAY OF FISSION PRODUCT MIXTURES

IV GAMMA IONIZATION CHAMBER MEASUREMENTS
FOLLOWING THERMAL NEUTRON FISSION OF Pu^{239}

P. O. Strom, D. Sam, J. Mackin, and P. Zigman
15 September 1961 21 p. UNCLASSIFIED

Gamma ionization chamber readings are given for the products of thermal neutron fission of Pu^{239} for the period from 1 second to about 22 hours following fission. Using spectral data on U^{235} fission products and ionization chamber efficiency with gamma energy, the energy release rate of Pu^{239} fission products is determined as a function of time. The results are compared with those attained for U^{235} fission products.

USNRDL- TR- 529

PANCREATIC ISLET CELL TUMORS AND RENAL TUMORS IN THE
MALE RAT FOLLOWING NEUTRON EXPOSURE

V. J. Rosen, T. J. Castanera, D. J. Kimeldorf and D. C. Jones
27 September 1961 25 p. UNCLASSIFIED

During a study of the long term and late effects of fast neutron exposure in the rat a large number of primary pancreatic and renal neoplasms was observed at autopsy. The incidence of pancreatic islet cell tumors among nonirradiated control animals was 17 percent whereas the same tumor was found in 56 percent of the animals exposed to 230 rads and 44 percent of those exposed to 320 rads. The functional significance, if any, of these tumors has not been established. Most of the animals with islet cell tumors also had primary tumors in one or more of the other endocrine tissues, although no

specific pattern of concomitant tumors was discernible. Renal neoplasms in the form of adenomas, carcinomas, and transitional cell carcinomas were found in 41 percent of the animals exposed to 230 rads and in 43 percent of those exposed to 320 rads. No renal neoplasia was observed in the nonirradiated controls derived from the same litters. This finding suggests that renal neoplasia in these rats is a response to radiation rather than an event in the normal ageing process. On a rad dose basis, neutrons are more potent than X rays for the induction of both islet cell and renal parenchymal tumors.

USNRDL-TR-531

EVALUATION OF RADIOLOGICAL HAZARDS RESULTING FROM
NAVAL REACTOR ACCIDENTS (U)

M. G. Gibbons and J. R. Hippensteele
15 August 1961 149 p. SECRET RESTRICTED DATA

(Distribution restricted:)

USNRDL-TR-532

ACCELERATED INDUCTION OF NEOPLASMS IN MOUSE KIDNEYS
X-IRRADIATED (690 RAD) WHILE UNDERGOING COMPENSATORY
HYPERPLASIA

V. J. Rosen and L. J. Cole
11 October 1961 19 p. UNCLASSIFIED

Groups of young adult (C57L x A)F₁ mice were subjected to several different treatments: a) 690 rad whole-body X-irradiation; b) unilateral nephrectomy and no irradiation; c) 690 rad irradiation followed by unilateral nephrectomy 1 hour later; d) unilateral nephrectomy followed by 690 rad irradiation 3 hours later; e) unilateral nephrectomy, 690 rad 3 hours later. The mice were examined 1 year or 18 months later for kidney neoplasms. The group nephrectomized and irradiated 3 hours later showed a high incidence (10 out of 19) of

kidney adenomas, as compared with none in the mice irradiated only, or nephrectomized only. In addition, a high incidence (11 out of 15) of tubular and Bowman's capsule proliferations was observed in the mice subjected to irradiation first and nephrectomy 1 hour later. These proliferations are considered to be early stages in the evolution of the frank renal adenoma. Since the accelerated induction of kidney neoplasms observed, occurred under conditions which inhibit mitotic activity and compensatory hypertrophy in the mouse kidney, it is proposed that the development of these renal neoplasms is the consequence of a prolonged imbalance between the stimulus to hyperplasia on the one hand, and the capacity for hyperplasia in radiation-altered kidney cells on the other.

USNRDL-TR-533

GAMMA-RAY PENETRATION EXPERIMENTS FOR A LIGHT AIR-CRAFT CARRIER USING DISTANT SOURCES AND SOURCES SIMULATING CONTAMINATION OF THE HULL

S. Tomoeda, M. B. Hastings and W. G. Miller
19 October 1961 83 p. UNCLASSIFIED

The penetration of gamma rays into compartments of an aircraft carrier from two different radioisotopes was measured in two different experiments.

In one experiment, cobalt-60 and cesium-137 point isotropic sources were exposed near the hull of the ship to simulate hull contamination. Measurements of dose were made in the forward part of the ship at four different deck levels. Dose distribution data are presented for the two sources used and for the different source points considered.

In the second experiment, a nominal 500-curie collimated cobalt-60 source was exposed at a distance of roughly 100 feet from designated points to irradiate two general regions of the ship. Dose distributions are presented for each of 18 different source positions used. Five decks were instrumented in each of the two general regions considered.

Diagrams indicating source positions, detector positions, and hull-plating thicknesses are also presented.

USNRDL-TR-534

DYNAMIC FLAW DETECTION USING PENETRATING RADIATION
AND SCINTILLATION DETECTION

K. F. Sinclair and G. W. Hitchcock
10 October 1961 35 p. UNCLASSIFIED

This report covers the design and performance of continuous scan type flaw detection systems for use in the detailed examination of solid propellant missile motors. The factors affecting performance are discussed individually and related in a system equation. An experimental system, using two scintillation detectors in a differential configuration, is described and tests performed using isotopic and X-ray sources are reviewed. The predicted performance and the experimental results obtained are compared.

USNRDL-TR-535

GAS-CHROMATOGRAPHIC SEPARATIONS OF RARE GASES

C. L. Carnahan
2 November 1961 39 p. UNCLASSIFIED

A procedure was developed for the separation of the rare gases argon, krypton, and xenon from mixtures containing oxygen and nitrogen by use of gas-chromatographic columns packed with molecular sieve type 5A. Helium was the carrier gas. The method is applicable to mixtures which have been considerably enriched in the rare gases. The procedure involves:

- a. Separation of xenon from oxygen, nitrogen, argon, and krypton on a short column at or above room temperature;
- b. Separation of krypton from oxygen, nitrogen, and argon on a long column at -20°C;
- c. Separation of argon from oxygen on the long column at -50°C.

The net reduced retention volumes and heats of adsorption were determined for oxygen, nitrogen, argon, krypton and xenon on molecular sieves, types 4A, 5A and 13X.

Voltage output of the differential thermal conductivity detector was measured as a function of the quantity of gas being measured. It is estimated that the presence of about 6×10^{-11} mole, or 0.1 ppm in 25 cc of sample, can be detected. Quantitative measurements can be made down to about 5×10^{-9} mole, or 10 ppm in 25 cc of sample.

USNRDL-TR-536

EFFECT OF POTASSIUM BICARBONATE ON THE IGNITION OF CELLULOSE BY THERMAL RADIATION

A. Broido and S. B. Martin
2 October 1961 23 p. UNCLASSIFIED

In accord with the established effectiveness of KHCO_3 as a fire-extinguishing agent, it has been shown that KHCO_3 treatment of α -cellulose papers prior to their exposure to thermal radiation reduces their sensitivity to transient flaming and that sustained flaming may be completely prevented without adding more than 1.5 percent by weight. On the other hand, KHCO_3 treatment greatly increases the sensitivity of cellulose to glowing ignition, apparently by increasing the rate and degree of pyrolysis. Treatment particularly enhances the production during pyrolysis of such combustible gases as H_2 , CH_4 , C_2H_4 , and C_2H_6 at the expense of high molecular weight, tarry materials.

USNRDL-TR-537

BIOELECTRIC POWER AND WORK IN GASTRO-INTESTINAL TISSUE

B. E. Vaughan and A. K. Davis
21 November 1961 41 p. UNCLASSIFIED

An original method of measuring bioelectric power and electro-motive work is described for tissues during the limited period of viability following excision from the body. These electrical characteristics have been shown to be dependent on aerobic metabolism under homeothermic conditions, and their relationship to net ionic

movement has been explored, indicating that an ion sieve effect takes place when the membrane is supplied with electrical energy. The method has been found to be applicable to stomach, caecum, and skin; although this report, primarily describes the methods as they are applied to rat stomach and caecum.

USNRDL-TR-538

AN ANALYSIS OF TRITIUM HAZARDS (U) (SHORT TITLE)

J. D. Teresi, R. A. Sulit and W. Lu
1 December 1961 70 p. SECRET RESTRICTED DATA

(Distribution restricted)

USNRDL-TR-540

NICKEL CADMIUM CELLS FOR USE IN PORTABLE INSTRUMENTS
AND SEVERAL METHODS OF RECHARGING THEM

R. L. Hopton
19 December 1961 24 p. UNCLASSIFIED

This report covers an evaluation of several types of nickel cadmium rechargeable cells under consideration for use in sealed and nonsealed portable instrument systems. Temperature, discharge rate, capacity, rechargeability and interchangeability were checked and found to be generally satisfactory where the different terminal voltage requirements per cell were compatible with the existing instrument. Types of cells ranging from the "D" size down to a button type of 50 ma-hr capacity were tested and methods of recharging them considered. A universal, series regulator type of charger is discussed which will charge these cells in the constant voltage mode. Also discussed is a silicon solar cell charger for use where adequate light is available.

USNRDL-TR-541

COCRYSTALLIZATION OF ULTRAMICRO QUANTITIES OF IRON
AND OTHER ELEMENTS WITH OXINE GENERATED IN SITU

H. V. Weiss and W. H. Shipman
31 October 1961 23 p. UNCLASSIFIED

The cocrystallization of iron in trace quantities with oxine formed homogeneously in solution by the hydrolysis of 8-acetoxy-quinoline was studied. The distribution of microcomponent between the solid phase and the mother liquor was profoundly affected by the degree of supersaturation. After relief from supersaturation, a constant distribution coefficient was calculated by an equation which was predicated upon the Doerner-Hoskins equilibrium. The cocrystallization of other elements was also examined with an arbitrarily established set of conditions. Plutonium, cerium, and praseodymium were quantitatively recovered from solution.

USNRDL-TR-542

THE DETERMINATION OF ESTERIFIED FATTY ACIDS IN GLYCERIDES,
CHOLESTEROL ESTERS AND PHOSPHATIDES

W. D. Skidmore and C. Entenman
11 January 1962 44 p. UNCLASSIFIED

The hydroxamic acid reaction conditions for the determination of esterified fatty acids have been modified to the extent that the variable factors involved have been controlled so that the molar absorptivities per ester group for triglycerides, cholesteryl esters of long-chain fatty acids, and phosphatides were equivalent through 8 μ Eq ester. The amount of water present during the formation of hydroxamates was the most important single factor in obtaining equivalent color values with these three types of esters. The accuracy and precision of the method have been well defined by showing that the optical density values for five different ester standards were on the identical straight line curve. Spectral curves between the wavelengths of 410 $\text{m}\mu$ and 700 $\text{m}\mu$ with standard carboxylic acid esters and Folch extracts of rat serum, rat liver, and human serum were qualitatively and quantitatively identical. A long-chain cholesteryl

ester must be used as one of the standard esters because of its solubility characteristics and water sensitivity. Cholestryl acetate can not be used as a reliable representavie in place of a long chain cholestryl ester.

USNRDL-TR-543

THE EFFECT OF COLLIMATION ON THE RESOLUTION AND
PEAK-TO-TOTAL RATIO OF A NaI(T1) CRYSTAL

F. M. Tomnovec and P. A. Read
31 January 1962 20 p. UNCLASSIFIED

Restricting the incident radiation to a small area of a NaI(T1) scintillation crystal improves the resolution and peak-to-total ratio of the spectrometer. This effect was studied with a series of tapered lead collimators, all with the same apex but with differing apertures, in front of a 4 in. by 4 in. diameter NaI(T1) scintillation crystal. Sources of gamma rays with energies from 0.28 to 2.76 Mev were located at the apex of the taper. Optimum resolution of about 25 percent greater than broad-beam resolution was obtained with a 0.25-in diameter aperture. Anomalous effects were observed with a smaller opening.

USNRDL-TR-544

A QUALITATIVE STUDY OF RADIO-FREQUENCY INTERFERENCE
RADIAC-TELEMETRY SYSTEMS

H. A. Zagorites and D. Y. Lee
8 February 1962 20 p. UNCLASSIFIED

With the need for radiological data for military purposes and public safety, radio telemetry may be used extensively in the transmission of radiological information. The use of radio telemetry in nuclear radiation measuring systems introduces potential radio-frequency interference (RFI) problems in the detector elements of the system, due to the telemetry transmitter, and in the reception

process, due to noise. Also, data accuracy may be reduced by the bandwidth limitation of the telemetry system.

In an effort to better understand the effects of RFI and bandwidth limitation on data accuracy and reliability, a number of qualitative tests were made with an existing recycling electrometer type of radiation recorder coupled to a standard telemetry system. These tests, which showed that significant errors can result from RFI, demonstrated the need for system designs which minimize radio-frequency (r.f.) coupling to the high impedance elements of the radiation detector and circuitry. RFI in the radiation recorder tested caused an increase in the recycling period of 20 percent or more under some conditions. This increase was attributed to the recharging of the radiation detector by the r.f. through the diode action of the electrometer tube. Also, it was found that the effect of bandwidth limitation on the transmitted pulse output of the recorder was small and that the system accuracy was not significantly lowered. However, system noise reduced reliability at very low pulse repetition rates.

The test results showed that potential RFI problems exist in radiac-telemetry systems. Most of these problems can be met satisfactorily through the use of common r.f. elimination techniques.

USNRDL-TR-545

EVALUATION OF RADIATION HAZARDS ASSOCIATED WITH
OPERATION OF NUCLEAR-POWERED SPACE UNITS AT
PACIFIC MISSILE RANGE

C. L. Newcombe, J. L. Mackin, A. Bankofier and T. O. Yep
1 February 1962 258 p. FOR OFFICIAL USE ONLY

The potential radiation hazards from the testing and launching of nuclear-powered space units at the Naval Missile Facility, Point Arguello (NMFPA), are evaluated by using a hypothetical

1-Mw thermal power nuclear reactor, operating for 1, 5, 20, or 60 minutes, as a point of reference in calculating releases of radioactivity and the resulting hazards. The evaluation indicates that test operations using presently planned nuclear reactor units up to about 10-Mw thermal power (maximum integrated power of 1000 Mw-sec) are feasible at NMFPA.

USNRDL-TR-545 (Supplement)

RADIATION HAZARDS ASSOCIATED WITH OPERATION OF
SNAP, ROVER, AND PLUTO NUCLEAR-POWERED SPACE
UNITS (U)

A. Bankofier, C. L. Newcombe, J. D. Teresi and
J. L. Mackin
29 October 1962 131 p. SECRET RESTRICTED DATA

Supplement to evaluation of radiation hazards associated
with operation of nuclear-powered devices at Pacific Missile
Range, by C. L. Newcombe and others. (Abstract UNCLASSIFIED)

USNRDL-TR-546

THE INFLUENCE OF A HYPERCALORIC DIET ON GROSS
BODY AND ADIPOSE TISSUE COMPOSITION IN THE RAT

S. C. Peckham and C. Entenman
5 February 1962 33 p. UNCLASSIFIED

The total fat content of the epididymal fat depot of the rat was found to be a function of the number of fat cells (using DNA content as the index of cell number) in that tissue. The capacity for generation of these new cells was retained for at least the first 34 weeks of life.

Although the average body weight attained by rats fed a high-fat diet for 62 weeks was 37 percent greater than that of rats fed a standard pellet diet, the total amounts of ash, protein, and water were substantially the same for both groups; the difference in weight being essentially accounted for by the difference in fat content.

After ingestion of a high-fat diet, rats having an average weight 23 percent greater than that of rats fed a standard laboratory pellet diet, were capable of reverting not only to the average weight of rats on the pellet diet but also to the same body composition, when transferred from the high-fat to the pellet diet 31 weeks after weaning (34 weeks of age, or approximately 1/3 the total life expectancy). Basic differences appear to be retained, however, in that the animal formerly fed the high-fat diet had the ability to show a weight increase 40 percent greater than the rat fed pellets since weaning when both groups were placed on the high-fat diet 62 weeks after weaning. The data suggest that the greater weight gain may be related to a greater number of adipose tissue cells in the rats that had once been obese.

USNRDL- TR- 547

EFFECT OF CURE UPON CROSSLINKING, CHAIN SCISSION, AND COMPRESSION SET IN AN IRRADIATED RUBBER VULCANIZATE

W. E. Shelberg and J. F. Pestaner
10 January 1962 27 p. UNCLASSIFIED

A compressed natural rubber vulcanizate was exposed to 10^8 r of gamma radiation and allowed to reach its set length at 40°C after release from compression. Compression set, crosslinking and scission of the elastomer net work varied with degree of cure.

$$S = -0.66 \times 10^{-18} C_0 + 95.1$$

$$C_r = 0.26 C_0 + 21.5 \times 10^{18}$$

$$\Delta C_0 = 0.60 C_0 + 2.4 \times 10^{18}$$

where S = Percent compression set

C_0 = Number of vulcanization crosslinks per gram of specimen (degree of vulcanization)

C_r = Number of crosslinks engendered per gram of specimen in the compressed state by 10^8 r

ΔC_0 = Number of vulcanization crosslinks scissioned per gram by 10^8 r.

The average radiation yield (G) for chain scission and for crosslinking in the dose region from 0 to 10^7 r was 0.75 and 1.3, respectively. 9, 10-Phenanthrenequinone and 1, 4-naphthoquinone functioned as anti-rads at 10^8 r and reduced compression set moderately below that predicted from degree of cure.

USNRDL-TR-548

A METHOD OF INCREMENTAL RECORDING ON MAGNETIC TAPE

L. A. Perrine and H. A. Zagorites
12 February 1962 26 p. UNCLASSIFIED

The conventional method of recording pulse data on magnetic tape fails to fully utilize the optimum bit-packing capability of the recording tape at pulse rates less than the design maximum. A simple method of incremental recording is described wherein the tape is stepped one increment of length for each serial input pulse, allowing optimum bit-packing which is independent of pulse rate. The method is applicable to multi-channel recording of variable pulse rates up to 100 pps and to recording mediums other than magnetic tape. It is advantageous where low power drain and long recording time without tape reloading are required. An experimental

miniature incremental magnetic tape recorder, utilizing a commercially available stepping motor and having transistorized logic and drive circuitry is described. Test results are given and a method of data analysis for incrementally recorded tape by means of conventional playback is presented.

USNRDL-TR-549

DECONTAMINATION OF SHIPS' SURFACES.

II. DESIGN AND CONSTRUCTION OF EXPERIMENTAL FACILITIES

R. N. Anderson and R. M. Railey
30 January 1962 38 p. UNCLASSIFIED

A laboratory study of the fallout from a seawater nuclear detonation and its contamination of ships' surfaces requires special equipment to make the radioactive simulant, to generate and disperse the simulant on painted surfaces, and to decontaminate these surfaces by liquid methods.

The simulant is produced by evaporating 30 gal of seawater containing approximately 2 curies of a selected gamma-emitting radioisotope to a final volume of 3 gal. The concentrated solution is fed to a spinning disc generator which produces 200- μ diameter drops at flow rates from 0.06 to 2.5 ml/sec.

The drops are generated at the top of a polyethylene-lined chamber 36 ft high and, as they settle at terminal velocity, they are distributed by a rotating cluster of fans to uniformly deposit on plates 8.5 in. square. The plates are painted with Navy paints, and cover a floor area of 1256 ft².

The contaminated plates are counted, washed, and recounted at the rate of 50/hr in a machine which simulates firehosing and steam cleaning. The effects of solution temperature, spray pressure, spray time, and chemical additives in the liquid decontamination methods may thus be evaluated.

USNRDL-TR-550

RESIDUAL INJURY CAUSED BY IRRADIATION WITH FAST
NEUTRONS

J. S. Krebs and R. W. Brauer
26 February 1962 25 p. UNCLASSIFIED

The LD₅₀ of C₃H female mice for fission-spectrum neutrons was found to be 274.5 ± 4.2 rad. The previously reported* value in the same mice for 250 kvp X ray was 632 rad, giving an RBE of 2.30. Conditioning exposure of the mice to a total neutron dose of 482.3 ± 7.2 rad over an interval of 8 to 10 weeks resulted in lowering the LD₅₀ for neutrons by 41.8 ± 5.9 rad, or 8.67 ± 1.23 percent of the total conditioning dose. The previously reported* value in the same mice for 250 kvp X ray was 9.58 percent of the conditioning dose. Continued exposure of the mice to 166 rad doses of neutrons at intervals of 4 to 5 weeks gave a median survival time of 22 weeks. This was greater than that produced by exposure to 420 rad and less than that produced by exposure to 280 rad of 250 kvp X ray given at the same time. It is concluded that the RBE of the mice for residual radiation injury and the RBE for chronic radiation tolerance over short time intervals are the same as that for acute injury tolerance.

USNRDL-TR-551

COCRYSTALLIZATION OF ULTRAMICROQUANTITIES OF
ELEMENTS WITH THIONALID

DETERMINATION OF SILVER IN SEA WATER

M. G. Lai and H. V. Weiss
19 January 1962 21 p. UNCLASSIFIED

The cocrystallization of ultramicro quantities of 27 diverse elements with thionalid was investigated by radiotracer techniques. Under optimum pH conditions, greater than 90 percent of each of the following elements was recovered from solution: Au, Os, Ta, In, Hg, Ag, W, Zn, Sn, Tl, Co, Ir, Ru, Mn, Cr and Hf.

* Radiation Research 10, 80-88 (1959)

Limited distribution studies revealed that the Doerner-Hoskins distribution was inapplicable and that Fajans Rule was not obeyed.

Information derived from these experiments was applied to the isolation and determination of silver in sea water. After radiometric correction for its yield, the concentration of silver in sea water was determined to be $0.145 \pm 0.006 \mu\text{g}/\text{l}$.

USNRDL- TR-552

**PRELIMINARY WEAPONS EFFECTS PREDICTIONS FOR AEC
DIAGNOSTIC WEAPONS TEST SERIES (U)**

S. C. Rainey and R. W. Shnider
13 March 1962 48 p. **SECRET - FORMERLY RESTRICTED
DATA**

This report contains predictions of weapons effects to be expected from a proposed series of nuclear weapons tests in the Pacific area. Information on radiological, thermal, and shock effects is presented to provide personnel of Joint Task Force Eight with a basis on which to plan standoff distances for participating ships and aircraft; and to indicate the magnitude and type of effects to be expected under certain contingencies.

Shots are scheduled to take place at altitudes higher than one maximum fireball radius; consequently, local fallout will not occur, and in each case the hazard due to thermal radiation will be limiting. In the unlikely event that such a detonation takes place on the surface (due to some malfunction of the devices, which are to be dropped from aircraft), the resulting fallout will limit standoff over a wide sector. Thus fallout predictions are included for all shots. The extremely unlikely case of underwater bursts is also discussed.
(Abstract UNCLASSIFIED)

USNRDL- TR-553

DIFFERENCES IN THE REJECTION OF SKIN TRANSPLANTS AND
BLOOD CELLS OF BONE MARROW DONOR ORIGIN BY RADIATION
INDUCED CHIMERAS

M. S. Silverman and P. H. Chin
16 March 1962 26 p. UNCLASSIFIED

(C57L x A)F₁ mice which had survived lethal doses of X radiation when injected with rat bone marrow are frequently found to have rat circulating blood cells. These cells often persist for the remainder of the animal's life. In addition, the mouse/rat chimeras will also accept donor rat skin grafts. The acceptance or rejection of the skin grafts is often used to determine the immunological tolerant state of the chimera. However, the data described in this report indicate that the circulating blood cells may persist in about 50 percent of these mice although rejection of the skin grafts occurs. Some of these partially tolerant mice are capable of producing antibodies against sheep red blood cells, but not against rat blood cells of either donor or allelogeneic origin. Mice which have reverted to a completely nontolerant state reject both the rat skin grafts and rat circulating blood cells, and form antibodies against the donor red blood cells. Three possible explanations for partial tolerance are offered, none of which is mutually exclusive.

USNRDL- TR-554

TRANSMISSION AND SCATTERING PROPERTIES OF THE LOS
ANGELES, CALIFORNIA ATMOSPHERE IN AUGUST AND
SEPTEMBER 1960

E. R. Schleiger, J. R. Nichols and F. I. Laughridge
10 October 1961 102 p. UNCLASSIFIED

Measurements of peak irradiances have been made in Los Angeles, California, nighttime atmospheres at distances from 0.90 to 6.77 statute miles from a Xenon flashlamp radiating uniformly in all directions. The measurements were made at wavelengths 0.40, 0.50, 0.77 and 0.88 μ (microns) with receiver fields of view up to 64 degrees half-angle. From these data attenuation coefficients were

calculated for collimated transmission and aureoled transmission (4π source and flat receiver facing the source). Also calculated for aureoled transmission were values of R , the ratio of "scattered-in" radiation to direct radiation received by the flat receiver at various distances from the source. Angular scattering diagrams and attenuation coefficients for scattering were measured for radiation of wavelengths 0.40, 0.45, 0.50 and 0.55μ . Relations between these optical characteristics of the atmosphere and meteorological characteristics such as visibility, relative humidity, and contaminant contents were examined. Investigations of transmission variability with respect to both time and space were made. Curves were prepared from these and other experimental data showing transmittances of four typical atmospheres as a function of range for the case of flat receivers and radiation from a 4π black body source at 6000°K .

USNRDL-TR-555

MONOVALENT CATION EFFECTS ON A DNA-SYNTHESIZING SYSTEM

R. K. Main and E. R. Walwick
2 April 1962 22 p. UNCLASSIFIED

The rate of incorporation of tritiated thymidine into DNA, in a multienzyme (predominantly cytoplasmic) system derived from rat thymus, is strongly affected by the nature and concentration of certain monovalent cations, tested one at a time, in the incubation mixture. The data indicate a narrow pH-activity range with a pH optimum at 7.3. K^+ , at 50-60 nM concentrations, can increase the rate of thymidine incorporation into DNA by a factor of 3.4 over that attained in its absence; Na^+ , causes a 2.5-fold increase. Under optimum conditions, maximum stimulation of DNA synthesis by selected cations increases in the order, Li^+ , Na^+ , Cs^+ , Rb^+ , NH_4^+ , and K^+ . These are specific ion effects.

Under standard conditions, the rate of DNA synthesis catalyzed by this multienzyme system reflects the degree of denaturation of the DNA primer. Undenatured DNA exhibits little, if any, primer activity. After prolonged water-dialysis at 2°C , DNA acquires primer properties in a degree proportional to the amount of dialysis. For primer purposes, thermal denaturation (100°C for 7 minutes) is superior to water-dialysis (80 hours at 2°C).

Preliminary experimental evidence suggests that the K^+ -dependence, demonstrated for this thymus (cytoplasmic) multienzyme system, is a property of the polymerase system present therein.

USNRDL-TR-556

DEVELOPMENT OF TRANSPLANTATION ISOANTIGENS IN THE
MOUSE EMBRYO AND TROPHOBlast

M. L. Tyan and L. J. Cole
3 April 1962 16 p. UNCLASSIFIED

Female LAF₁ mice were mated with BALB/c males, and the pregnancies were surgically interrupted at various times of gestation. The embryos were extirpated, homogenized in Tyrode's solution, and equal quantities were injected subcutaneously into the mother and into a paired virgin LAF₁ female. One week following surgery and/or injection the mice were exposed to a lethal dose of whole-body X radiation (870 rad). Within 2 hours they each received an intravenous injection of $6 - 9 \times 10^6$ bone marrow cells derived from male BALB/c mice. The presence of paternal transplantation immunity antigens in the injected fetal tissue was indicated by death (within 21 day postirradiation) of the recipient mice, due to bone marrow rejection.

Transplantation immunity antigens were detected in the developing mouse embryo as early as the "1 day pregnancy" embryo. Twenty-one day mortalities following the injection of fetal tissue into non-pregnant female mice were as follows: first trimester - 39 percent; second trimester - 81 percent; third trimester - 98 percent. The data also show that the pregnant mother is to some extent immunologically non-reactive, since the injection of first trimester fetal tissue in this case elicited no 21-day mortality (0 out of 22). However, when second and third trimester fetal tissue was injected into the pregnant mothers, 21-day mortality was 66 percent and 82 percent, respectively. Therefore, the maternal tolerance of the embryo seems best explained by the presence of an immunologically inert barrier of trophoblastic cells, as demonstrated recently by Simmons and Russell.

USNRDL- TR-557

RESIDUAL CONTAMINATION OF QUARTERMASTER CORPS
CLOTHING AND PACKAGING MATERIALS

RETENTION OF SIMULATED DRY FALLOUT PARTICLES

F. K. Kawahara
23 March 1962 32 p. UNCLASSIFIED

This study was conducted to determine the amount and size of simulated dry fallout particles retained by various Quartermaster Corps clothing and packaging materials, after field decontamination procedures are applied. An attempt also was made to correlate qualitatively the amount retained with surface properties of the materials.

Dry, spherical, glass beads in selected size-distribution groups ($14-270 \mu$, $14-100 \mu$, and $14-75 \mu$) were used to simulate fallout particles from a nuclear detonation. The amount remaining was measured gravimetrically and visually by optical microscope after application of three mechanical removal operations.

It was found that materials having entrapping fibers retained the largest amount of beads. The amount was directly proportional to the number of open spaces and the number of loose fibers that acted as entrappers. Scrim-back packaging material retained $0.3 \text{ g}/\text{ft}^2$ of particles which had an average diameter of 50μ . Cotton sateen clothing and cotton poplin clothing had lesser amounts. All other materials tested retained zero or insignificant amounts.

Mechanical entrapment of particles by the loose fibers appeared to be the principal mechanism of retention.

USNRDL- TR-558

THE ANGULAR DISTRIBUTION OF DOSE RATE FROM GAMMA RAYS
SCATTERED THROUGH VARIOUS THICKNESSES OF IRON AND
ALUMINUM

T. S. Dahlstrom and W. E. Thompson
19 April 1962 74 p. UNCLASSIFIED

The angular distribution of dose rate resulting from gamma rays of Co^{60} and Cs^{137} transmitted through various thicknesses of iron (0.737 in. and 1.6 in.) and aluminum (2 in., 4 in., and 9 in.) was measured. These experimental results are compared with Monte Carlo calculations. Comparisons over a limited range of these angular variables are also made with dose-rate distributions calculated from gamma-ray spectrometric data.

USNRDL-TR-559

PRECISION MAGNETIC FIELD MEASUREMENTS USING HALL GENERATORS

T. S. Dahlstrom, H. A. Howe, W. M. Mallet and W. E. Smith
24 April 1962 46 p. UNCLASSIFIED

Accelerators employing magnetic fields require accurate measurement of these fields. Employment of the Hall effect in the recently developed semiconductors, indium-arsenide and indium-antimonide, meets these strict magnetic field measurement requirements. The semiconductors, produced and encapsulated by Siemens Corporation, have the following approximate characteristics depending upon the size and type of semiconductor. At the rated current through the semiconductor, the Hall voltage is about 0.1 v at 10 kgauss. The temperature coefficient is small (approximately 0.07 percent/ $^{\circ}\text{C}$) but varies as much as 50 percent for different magnetic fields. The long time stability is good with a measured variation over a year of less than 1 part in 10,000. Semiconductors with effective dimensions from 1 to 12 mm are available. With a special value of electrical load on the output terminals, linearity better than 0.5 percent is obtainable from 0 to 10 kgauss. A detailed description of the temperature coefficient of the Hall potential, the internal resistance of the semiconductor, will be presented along with a description of a temperature-compensating network which yields a magnetic field measuring probe with a temperature coefficient of less than 0.01 percent/ $^{\circ}\text{C}$ over a magnetic field range from 6 to 25 kgauss. The importance of thermal time constants of the semiconductor will be discussed and some measurement results presented.

USNRDL-TR-560

STUDIES ON RADIATION-INDUCED CHIMERAS

Early Development of Graft-to-Host Tolerance

Prevention of Secondary Disease by Isoantiserum and Preirradiation of Marrow Donor

L. J. Cole and W. E. Davis
30 April 1962 18 p. UNCLASSIFIED

Radiation bone marrow chimeras were prepared by injecting marrow cells from adult C3H strain donors into lethally X-irradiated (880 rad) LAF₁ mice. It was found that spleen cells from these chimeras (removed 35 to 57 days postirradiation) did not reject either donor (C3H) or host (LAF₁) type marrow cells, when transferred to other lethally X-irradiated recipients, but were able to reject marrow of a third inbred strain (BALB/c). Similarly, in a series of parental-F₁ hybrid lymphoid cell chimeras, spleen and lymph node cells from these chimeras (as early as 5 - 10 days after establishment of chimerism) in no instance elicited secondary disease deaths when transferred to new irradiated LAF₁ hosts. Yet these same cell populations were immunologically competent, as shown by their capacity to reject homologous (C3H strain) bone marrow. Thus, these cell populations have developed specific tolerance (i.e., nonreactivity) for their primary LAF₁ hosts as early as 1 week following initial transplantation.

C3H marrow donor mice were exposed to a single sublethal dose of X rays (400 rad); 12 or 16 days later their marrow was removed and injected into lethally X-irradiated LAF₁ recipients (22×10^6 cells injected per mouse). The incidence of secondary disease deaths (at 120 days) in these series was 0 out of 11, and 1 out of 8; in controls which received marrow from nonirradiated C3H donors, 6 out of 17 were dead by 120 days. Two additional groups of bone marrow chimeras received intravenous injections of isoantiserum (anti-C3H) at 16 and 18 days, or at 46 and 48 days after marrow infusion. No secondary disease deaths have been observed in 17 mice thus treated by 7 months postirradiation.

It is concluded: 1) that specific graft-to-host tolerance may develop relatively early in radiation chimeras; 2) that it is possible to prevent or eliminate secondary disease in homologous radiation chimeras by suitable preirradiation of the marrow donors, and by injection into the chimeras of specific isoantiserum directed against the marrow donor.

USNRDL- TR-561

EVIDENCE FOR DIRECT STIMULATION OF THE MAMMALIAN
NERVOUS SYSTEM WITH IONIZING RADIATION

E. L. Hunt and D. J. Kimeldorf
7 May 1962 16 p. UNCLASSIFIED

In a behavioral study designed to detect the most immediate reaction of the intact nervous system to ionizing radiation, rats were exposed while asleep to X rays (250 kvp), and measurements of behavioral arousal and heart rate were made to indicate activation of the central nervous system. A transitory behavioral arousal was exhibited within 12 sec at an exposure rate of 0.25 r/sec. At a higher dose rate of 1.9 r/sec this initial reaction increased in scope and by 30 sec included subcortical activation as well, as indicated by a heart rate response. These reactions depended upon the rate of exposure and not upon the total dose. In blinded animals, exposure at the high intensity evoked both the behavioral arousal and the heart rate response. This indicates that CNS activation cannot be attributed to the direct effect of radiation on the visual receptor system. Although radiation may act as a stimulus to the CNS through other sensory systems, it was also suggested that the nervous system itself is directly sensitive to ionizing radiation.

USNRDL- TR-562

THE EFFECT OF WHOLE BODY X-IRRADIATION ON BLOOD
PRESSURE IN THE RAT

R. D. Phillips and D. J. Kimeldorf
8 May 1962 30 p. UNCLASSIFIED

Blood pressure was measured at a peripheral and central site in the rat. Pressure at the peripheral site was determined by a tail occlusion cuff method, while central pressure was measured by aortic intubation. There was a marked decrease in blood pressure measured at the peripheral site 8 hours after the animals were exposed to 485 rads of X rays, with a return to control values by 3 days after exposure. Aortic blood pressure, however, was not altered at this dose level. There was a mild decrease in aortic pressure 24 and 48 hours

after 970 rads and a marked hypotension 8 and 24 hours following 1940 rads. The aortic blood pressure response to various stimuli was also altered after 970 rads, but not after 485 rads of X rays. These data demonstrate that blood pressure at a peripheral site can be decreased at a dose level which does not affect central pressure. It is suggested that this differential effect in blood pressure is a result of a radiation response in peripheral circulation.

USNRDL-TR-563

TWO-DIMENSIONAL THIN-LAYER CHROMATOGRAPHY OF RAT LIVER PHOSPHATIDES

W. D. Skidmore and C. Entenman
11 May 1962 33 p. UNCLASSIFIED

A system of two-dimensional, thin-layer chromatography was developed that separated rat liver phosphatides into several phosphate positive spots between the origin and the intersection of the solvent fronts in about 2 hours' developing time. Characteristic hydrolysis products derived from phosphatidyl serine, phosphatidyl ethanolamine, phosphatidyl inositol, phosphatidyl choline, sphingomyelin, and lysophosphatidyl choline were identified. The hydrolytic products of "phosphatidic acid" were not definitely characterized. The application of thin-layer chromatography as described for rat liver phosphatides can be extended to phosphatide extracts of other tissues.

USNRDL-TR-564

COCRYSTALLIZATION OF ULTRAMICRO QUANTITIES OF ELEMENTS WITH 2-MERCAPTOBENZIMIDAZOLE

DETERMINATION OF GOLD IN SEA WATER

H. V. Weiss and M. G. Lai
11 May 1962 18 p. UNCLASSIFIED

The cocrystallization of ultramicro quantities of 25 diverse

elements with 2-mercaptopbenzimidazole was investigated with the aid of radio-tracers. Under optimum conditions Sn, Hg, Ag, Ta and Au were recovered in high yield.

Distribution coefficients between mother liquor and solid phase were calculated for gold and were found to vary inversely with the degree of crystallization and the hydrogen ion concentration.

The cocrystallization process was applied to the isolation and subsequent determination of the natural gold abundance in sea water. After radiometric correction for chemical yield, the concentration of gold was calculated to be $0.068 \pm 0.003 \mu\text{g/l}$.

USNRDL-TR-565

THE SELF-RADIATION OXIDATION OF TRITIUM IN OXYGEN AND AIR

G. J. Casaletto, L. H. Gevantman and J. B. Nash
8 May 1962 25 p. UNCLASSIFIED

The rate of self-radiation oxidation of tritium has been studied in atmospheres of oxygen and air by direct analysis of products as a function of time.

Second-order dependence on tritium concentration was observed below 1 mc/ml. Rate constants were determined to be $1.2 \times 10^{-3} \text{ ml}/\text{mc-hr}$ in oxygen and $0.62 \times 10^{-3} \text{ ml}/\text{mc-hr}$ in dry air.

The reaction rate was found to be independent of oxygen concentration and surface area at constant total pressures above 100 mm but to drop off sharply below this value.

The rate in oxygen is increased threefold in the presence of water vapor. The rate in atmospheric air, although poorly reproducible, is essentially the same as in dry air.

USNRDL- TR-566

VAPOR PRESSURES IN THE LIQUID SYSTEM Rb_2O - B_2O_3 .
DERIVED THERMODYNAMIC DATA AND A STRUCTURAL
INTERPRETATION

C. E. Adams and J. T. Quan
6 June 1962 69 p. UNCLASSIFIED

By use of the transpiration method, the vapor pressures of the liquid system Rb_2O - B_2O_3 between pure B_2O_3 and Rb_2O . B_2O_3 have been measured. The vapor over the entire composition range was an equimolar mixture of Rb_2O and B_2O_3 . Data from other sources indicate that the vapor molecule should be $RbBO_2$. The activity of the $RbBO_2$ in the melts showed a pronounced discontinuity at about 15 mole percent Rb_2O . The activity and other thermodynamic data were compatible with a liquid structure based on Biscoe and Warren's theory, which describes the structures of alkali borate glasses. The activity of the $RbBO_2$ in the melts and the vapor pressure of the $RbBO_2$ above the melts could be decreased by the addition to the melt of oxygen-complexing cations.

USNRDL- TR-567

RESPONSE REQUIREMENTS FOR MILITARY RADIACS

3. APPLICATION OF A RELIABILITY PREDICTION TECHNIQUE
TO A NAVY RADIAC

J. A. Kunzman and H. R. Wasson
11 June 1962 61 p. UNCLASSIFIED

An established reliability prediction technique (NAVSHIPS 900-193, TR1100) has been applied to a recent portable radiac, the AN/PDR-27(J). This theoretical analysis yielded a probable mean-time-between-failures (MTBF) of 5056 hr with an uncertainty of ± 40 percent. A debugging period of 160 hr was also predicted.

The theoretical analysis was confirmed by a laboratory test of 100 instruments operating for 1,000 hr. An exponential life curve was demonstrated with an MTBF of approximately 7,000 hr. The

range for a 90 percent confidence level was from 4,840 to 12,250 hr. The empirical debugging period was about 98 hr.

Conclusions are drawn concerning the utility of applying this type of reliability analysis to small portable cardiac devices.

USNRDL- TR-569

EVALUATION AND CALIBRATION OF AN ELECTRONIC PARTICLE COUNTER FOR MULTISPECIES BLOOD CELL ENUMERATION

W. G. Wisecup and B. G. Crouch
20 June 1962 21 p. UNCLASSIFIED

In order to standardize procedures and allow for large numbers of determinations in a relatively short time, a Coulter Model A Electronic Particle Counter was calibrated for enumerating total erythrocyte and leucocyte counts in twelve mammalian species. Standard values were obtained with blood from each species for all instrument settings (threshold, aperture current, etc.) and for optimal amounts of a stromatolytic agent for enumerating leucocytes. Two identical instruments were compared to determine the feasibility of using standard settings from one instrument to another. Findings showed that for the burro, dog, goat, guinea pig, hamster, man, monkey, mouse, rabbit, rat, sheep and swine the enumeration of total erythrocytes and leucocytes can be easily and accurately determined using the Coulter Counter. Further evidence suggests that standardized settings may be used with other instruments of the same model.

USNRDL- TR-570

RADIOLOGICAL RECOVERY OF LAND TARGET COMPONENTS -
COMPLEX I AND COMPLEX II

W. L. Owen and J. D. Sartor
25 May 1962 236 p. UNCLASSIFIED

Facilities escaping physical damage from a nuclear attack still may have to cope with hazardous amounts of fallout material. The survival of personnel and the resumption of vital missions could depend upon the timely removal of the fallout deposits. The safe performance of such a removal effort is possible only if a detailed radiological recovery plan exists before attack.

Two closely similar experiments were conducted on the operational recovery of an artificially contaminated land target complex. In each case a suitable recovery plan was formulated and then executed. The results showed that, within prescribed dose limits, pre-attack planning of a radiological recovery operation is not only feasible but strongly recommended.

USNRDL- TR-571

HOMOLOGOUS BONE MARROW TRANSPLANTATION IN DOGS RECEIVING X RADIATION PLUS URETHANE OR 6-MERCAPTO-PURINE

L. J. Cole and E. L. Alpen
19 July 1962 36 p. UNCLASSIFIED

Experience has now been accumulated with homologous marrow transplantation in 13 mongrel dogs (Group 1) treated with 6-mercaptopurine (6-MP) or urethane prior to X irradiation (900 r, delivered at a dose rate of 15 r/minute). The marrow dose was $7-11 \times 10^9$ cells, given on the day following irradiation; urethane (175 or 350 mg/kg) and 6-MP (12.5 or 25 mg/kg) were administered at three or four daily intervals during the week prior to irradiation. Mean survival time (MST) in Group 1 was 23 days, with a maximum of 63 days. MST in a group of dogs (Group 2) given homologous marrow after 900 r, but not treated with the chemicals, was 10 days. Group 1 animals characteristically showed good recovery of peripheral blood granulocyte count by 8-10 days, together with objective evidence of marrow "take"; recovery of mononuclear cell count was not observed, except in the single case which survived for 63 days. None of the Group 2 animals showed any rise in the peripheral blood count after initial depression, and all died with marrow aplasia. Secondary disease in Group 1 dogs was characterized by anorexia, weight loss, infection, and lymphoid tissue aplasia in all the animals; skin atrophy, liver lesions, jaundice and anemia were seen in some of the animals.

The marrow showed active hematopoiesis and moderate to good cellularity in most of the Group 1 animals, although megakaryocyte activity was deficient in some. Pneumonia and pulmonary edema were found in many of the dogs, at autopsy. It is evident that the use of these antimetabolites permits the successful transplantation of homologous marrow in dogs at a dose of X radiation (900 r) which, by itself, is insufficient. These compounds (urethane and 6-mercaptopurine) are, therefore, additive to X radiation with respect to suppressing the homograft reaction in dogs, as well as in mice.

USNRDL- TR-572

A METHOD FOR THE ANALYSIS OF COMPLEX PEAKS OCCURRING IN GAMMA RAY PULSE HEIGHT DISTRIBUTIONS

C. L. Carnahan
17 July 1962 46 p. UNCLASSIFIED

A method is described which can be used to compute the areas of overlapping peaks occurring in gamma-ray pulse height distributions in which the data are obtained in the form of histograms. The method is applicable to the study of nuclear decay schemes and to the analysis of mixtures of radionuclides. The method can also be used to determine the energy of a gamma ray giving rise to a peak which is obscured by one or two other peaks from gamma rays of known energies.

The method is based on the assumption that the events contributing to peak area are distributed about a central location according to the normal probability distribution. Prior calibration of the pulse height analyzer with sources of known energy is necessary for the application of the method.

USNRDL- TR-573

OXYGEN CONSUMPTION BY THE ISOLATED RAT LIVER -
EFFECTS OF HEMATOCRIT, TEMPERATURE, PERfusion RATE
AND OXYGEN TENSION

R. W. Brauer, G. F. Leong and R. J. Holloway
24 July 1962 37 p. UNCLASSIFIED

The steady state oxygen consumption of the isolated rat liver preparation (\dot{V}_{O_2}) was measured under a variety of conditions. At 37^0C , perfusion rate failed to affect \dot{V}_{O_2} except insofar as the perfusion fraction was reduced at low perfusion pressures. At lower temperatures, constant \dot{V}_{O_2} persisted even in the face of some reduction in perfusion fraction. The temperature dependence of \dot{V}_{O_2} is complex, showing at least 2 temperature coefficients, one at low perfusion temperatures ($28-33^0C$) corresponding to an Arrhenius constant of 16500 cal., and a lower one (Arrhenius constant about 9000 cal.) in the vicinity of 37^0C . The estimated basic rate of O_2 consumption of the rat liver under physiological conditions is 7.8 ml/g/hr, corresponding to 25 percent of the total BMR of these 300-400g. rats. \dot{V}_{O_2} is sensitive to perfusion hematocrit, the extrapolated value for \dot{V}_{O_2} in an erythrocyte free perfusate being close to 2.0 ml/g/hr. The degree of O_2 saturation of whole blood supplied to the liver likewise affects \dot{V}_{O_2} in a manner which indicates that a "critical P_{O_2} " for the liver, if it exists at all, must be in excess of 90 or 100 mm Hg venous P_{O_2} . The several sets of data are discussed from the point of view of the difficulty of reconciling them with current concepts of O_2 transfer, and of possible mechanisms which might be involved in respiratory regulation in the liver.

USNRDL-TR-574

A LOW RATE PORTABLE COUNTER

R. H. Sorenson and G. T. Kiyoi
28 June 1962 18 p. UNCLASSIFIED

Measurement of low radiation levels is difficult with present count-rate radiacs because of the excessive meter fluctuations on the low ranges. An accessory has been developed which increases the readability of the low ranges in these devices. The low-rate portable counter is intended for use where the counting rates are below 5,000 counts per minute. The instrument utilizes the output pulse normally

used to operate headphones, and supplies the operator with a digital display in counts for a preset time. Four fixed counting periods are available: 2, 4, 8, and 15 min. Transistor circuitry is employed, and power is supplied by an internal rechargeable battery source or from a 115-v, 60-cycle line. The AC power supply is also used to recharge the battery pack. The instrument described is intended to be a preliminary model; and although electrical performance was found to be satisfactory, military requirements for vibration and shock were not adhered to.

USNRDL-TR-575

LATE EFFECTS STUDIES ON RADIATION-INDUCED HOMOLOGOUS
MOUSE CHIMERAS: LONGEVITY AND INCIDENCE OF LEUKEMIA

W. E. Davis, L. J. Cole, W. A. Foley and V. J. Rosen
26 July 1962 26 p. UNCLASSIFIED

In connection with studies on lymphoid cell chimerism and homograft tolerance in long-lived homologous radiation chimeras, data have been collected on life span, and on occurrence of leukemia and other lesions. The chimeras were (C57L x A)F₁ hybrid mice (10-12 weeks old) exposed to 880 rad of X radiation and injected with bone marrow cells from C3H donors. Out of a total of 119 mice combined from several subgroups, 65 percent were dead by age 32 weeks, with symptoms of secondary disease evident in the great majority. Relatively few deaths occurred between 32 and 75 weeks, and the maximum life span was 105 weeks. Histopathological data were obtained from many of these long-lived chimeras and also from a group of long-lived isologous marrow chimeras. There was an 80 percent incidence of glomerulosclerosis of moderate to severe degree, and a 20 percent incidence of arteriolarsclerosis in the kidney and spleen of the mice in both groups. Leukemias were observed in 5 out of 54 (9 percent) homologous chimeras, but none was found in the isologous chimera group. Also, two leukemias occurred in 13 chimeras (15 percent) which had been injected with lymphoid cells obtained from other long-lived homologous chimeras, and thus the progeny of the injected cells have persisted for as long as 80 weeks. The possibility of a causal relationship between secondary disease and the increased incidence of leukemia, as well as the apparent decrease in life span is briefly discussed.

THE RELATIVE POTENCY OF FAST NEUTRONS AND 250 KVP
X RAYS IN THE GUINEA PIG

R. D. Phillips, D. J. Kimeldorf and D. C. Jones
6 August 1962 35 p. UNCLASSIFIED

The 30-day lethality response in Hartley strain guinea pigs was determined for fast neutrons and 250 KVP X rays. The LD 50/30 for animals exposed to neutrons was 155 rads, while for animals exposed to X rays it was 273 rads. Most deaths occurred 9-16 days after irradiation, and no deaths occurred before day 7 post-irradiation with either neutrons or X rays. Morphological examination indicated no marked gastrointestinal damage in the guinea pig following either neutron or X-ray exposure in the lethal range. The most frequent finding at autopsy was hemorrhage. Only minimal gastrointestinal damage was seen following supralethal exposures of neutrons or X rays.

Body weight, food consumption and water consumption were also determined for 30 days following irradiation. There was a mild depression in these three measurements during the first week following exposure and a marked decrease in all three measurements 9-16 days after irradiation. The relative potency of neutrons with respect to X rays was greater than unity for depressions in these three measurements. Food and water consumption values of survivors returned to control values by 30 days' post-irradiation. Body weight, however, remained less than controls for at least 30 days in a dose-dependent fashion. No evidence of a post-irradiation polydipsia was found.

The gastrointestinal syndrome is essentially absent in the guinea pig following either neutron or X irradiation; thus, it is presumed to be relatively unimportant as a factor contributing to death. The higher potency of fast neutrons compared to 250 KVP X rays for lethality in the guinea pig cannot be accounted for by a greater damage to the gastrointestinal tract. It is suggested that this greater potency of neutrons for lethality in the guinea pig may be explicable on the basis of radiation damage to the hematopoietic system.

EFFECTS OF NUCLEAR RADIATION ON SHIPBOARD
ELECTRONIC EQUIPMENT

I. SOME EFFECTS OF SIMULATED TRANSIT RADIATION ON
PARTS.

a. TRANSISTORS

H. A. Zagorites, E. A. Carr and D. Y. Lee
3 August 1962 250 p. UNCLASSIFIED

Twenty-six transistor types have been irradiated in simulated transit radiation fields in the first phase of a study of nuclear radiation effects on shipboard electronic equipment. The results showed that satisfactory transistor circuit performance is probable where conservative circuit designs can be used. However, it was predicted that some circuits will be susceptible to malfunctions in operationally significant transit fields. Possible effects on equipment reliability are such that they cannot be ignored by the designer.

The tests were preceded by an evaluation of the nuclear warfare environment to estimate maximum radiation fields expected on combat effective ships. Fields based on these estimates were simulated with Co^{60} and provided a peak dose rate of about 250,000 r/hr and a dose of 13,100 r.

A wide range was observed in the amount of radiation-induced effects on β and I_{CO} , even within a group of one type of transistor. In general, only temporary changes were observed, with silicon types exhibiting smaller effects. For germanium types, I_{CO} was observed to change by a factor of 10-20 for some types while β changed by a factor of 2 or less, with the change persisting in some types.

Analyses failed to show any strong correlations, in general, between radiation-induced effects and between these effects and pre-irradiation characteristics of the transistors. In addition, the results indicated that behavior of an individual transistor cannot be predicted satisfactorily from preirradiation measurements. Conservative circuit design and improvement of transistor performance during irradiation appear to be the best approach to the problem of equipment reliability.

USNRDL-TR-578

THE FAMILY OCCUPANCY TEST 4 - 6 NOVEMBER 1960

W. E. Strope, H. S. Etter, D. P. Schultze and J. I. Pond
22 August 1962 77 p. UNCLASSIFIED

The USNRDL experimental shelter at Camp Parks, California, was occupied for a period of 48 hours by 99 men, women, and children. Ages of the participants ranged from about 3 months to 68 years. Family size ranged from single persons to a family of seven. All aspects of the shelter environment as well as the actions and responses of the shelterees were monitored. Children of all ages appeared to adapt well to shelter conditions, but the importance of careful preparation, organization, and control of activities was demonstrated. This is a preliminary report made in advance of complete analysis of the data.

USNRDL-TR-579

THE RADIOBIOLOGY OF TEETH

D. J. Kimeldorf, D. C. Jones and T. J. Castanera
31 August 1962 58 p. UNCLASSIFIED

The literature regarding radiation effects upon teeth has been summarized and reviewed. Radiation effects upon teeth have been observed in a variety of species including man. Where sufficient data are available to form a judgment, it appears that the pattern of alteration is similar among species. The effects are dependent upon exposure factors and the state of tooth development at the time of irradiation. If the dose is massive, the effects may also involve damage to the tooth supportive structures. Radiation alters or destroys those odontogenic cells which are actively proliferating and differentiating at the time of exposure. If irradiation occurs before the formation of hard tissues, it may destroy the tooth bud. Radiation at a later stage in development may alter differentiation or arrest further growth. The severity of the effect is dependent upon the radiation dose. Mature tooth structures are affected primarily by relatively large doses although histologic evidence of damage in growing teeth of rodents may be detected with 25 r of X rays. The patterns of

injury and regeneration for the various tissues of the tooth are presented. In terms of radiobiological mechanisms it appears that direct radiation injury to teeth consists primarily of an interference with mitosis of proliferative tissues and the impairment of metabolic processes in differentiating cells.

USNRDL- TR-580

ENERGY RESPONSE OF LANDSVERK IONIZATION CHAMBERS TO MONOENERGETIC GAMMA RAYS

R. L. Lynn and V. L. DaGragnano
7 May 1962 27 p. UNCLASSIFIED

An energy response calibration of Landsverk L-65, L-81, and L-83 pocket chambers was carried out using monoenergetic gamma-emitting radioisotopes. Since the intensity of the sources was low, the pocket chambers were used as ratemeters and the ionization current was read on a vibrating-reed electrometer.

The dose rate of each isotope (Co^{60} , Cs^{137} , Hg^{203} , and Ce^{141}) was calibrated with a scintillation spectrometer.

The angular response of the chambers for the energies of 1.25 Mev, 662 Mev, 279 kev, and 145 kev, respectively, was measured in one quadrant. The effect of wall thickness on the energy response was also investigated.

USNRDL- TR-581

RADIATION EFFECTS IN THERMOELECTRICS

1. TECHNIQUES FOR DETECTION OF TRANSIENT EFFECTS AND THEIR APPLICATION TO COMMERCIAL GRADE BISMUTH TELLURIDE

J. W. Winslow and R. R. Hart
13 September 1962 86 p. UNCLASSIFIED

Two satisfactory laboratory methods for detecting and studying transient radiation effects on Seebeck coefficient, S , and electrical resistivity, ρ , of materials having large thermoelectric figures of merit, z , have been developed. The transient effects of intense beams of 2 Mev electrons on z in commercially available, thermoelectric grade bismuth telluride, have been deduced from separate observations of S and ρ made using these methods, together with previously reported observations of thermal conductivity. These observations indicate that ionizing radiation has no transient effects on the point value of z , within experimental limits of accuracy amounting to ± 50 percent. However, secondary effects very probably arising from inhomogeneity of the test material were observed. A simple model for, and some of the implications of, these observations are discussed.

USNRDL-TR-582

DESIGN MODIFICATIONS AND 1962 COST ANALYSIS FOR A
STANDARDIZED SERIES OF FALLOUT SHELTERS

L. G. Porteous
17 September 1962 131 p. UNCLASSIFIED

Major emphasis is on recent design modifications and 1962 cost estimates for the personnel fallout shelter described in USNRDL-TR-366, Specifications and Costs of a Standardized Series of Fallout Shelters (1959). The shelter is designed to accommodate at least 100 persons for 14 days. It is believed that the shelter will provide the specified fallout and blast protection, the required interior environment, and the essential "hotel-type" equipment at minimum cost. The shelter items are specified by several packages, each having one or more different arrangements of items, depending on the degrees of protection and comfort desired. The proper selection of packages will result either in a 35-psi or 10-psi blast and fallout shelter sited above or below grade. The radiation protection factor is at least 1000. "Most austere" to "least austere" living accommodations can be selected. Average cost data for the packages by item are tabulated for quantities up to 1000. Respective costs (less overhead, profit, etc.) for four complete shelters (combinations of most austere and least austere with 35-psi and 10-psi) have been estimated and are presented graphically. Costs for shelter quantities were estimated by means of learning curves. The costs range (one-off) from \$19,800 for the

least-austere 35-psi shelter to \$14,200 for the most-austere 10-psi shelter. The design modifications are based on findings of the USNRDL Shelter Research Program for the period, 1959 to June 1962.

USNRDL-TR-583

NEUTRON AND GAMMA-RAY DOSIMETRY IN AN ANIMAL EXPOSURE VOLUME AT A PULSED TRIGA REACTOR

R. E. Simpson, E. Tochilin and N. Goldstein
17 September 1962 30 p. UNCLASSIFIED

The distribution of steady-state and pulsed, neutron and gamma-ray dose was measured in an animal exposure volume at the TRIGA reactor at the General Atomic facility. The usable volume was restricted to the lower 20 in. of an aluminum irradiation tube having an ID of 9-1/2 in. The tube was inserted into the pool adjacent to the reactor void tank, 134 cm from the core.

Dosimetry films were used to determine gamma-ray dose while Sievert ionization chambers were used to determine neutron dose. Gold foils were used to measure the thermal neutron flux. Neutron doses were referenced to sulphur foil monitors. The neutron spectrum was examined with a system of threshold detectors and compared with spectra from Godiva II and the biological port of the Argonne CP-5 reactor.

The vertical variation of dose along a lucite board, designed for retaining mice, was measured at the midplane of a lucite canister lowered into the tube. The dose in the lower 16 in. was found to vary less than 5 percent. The ratio of neutron to gamma dose was approximately 6 to 1. A tissue equivalent dog phantom, 20 in. long and 7-1/2 in. in diameter, was designed to determine the absorbed dose in depth. The fast neutron dose was about equal to the gamma-ray dose at the midline of the phantom, having dropped from 2.3 times the gamma-ray dose in front of the phantom. The neutron plus gamma-ray dose at the midline was 44 percent of the dose at the front surface of the phantom. Bilateral exposure doses were computed from the unilateral exposures.

USNRDL- TR-584

QUALITY CONTROL FOR THE GAMMA-RAY SCINTILLATION
SPECTROMETER

D. F. Covell
17 September 1962 26 p. UNCLASSIFIED

Fluctuations, drifts or performance abnormalities in the scintillation gamma-ray spectrometer may completely invalidate its calibration and, under any circumstance, will lessen its precision of measurement. A technique patterned after well-established methods of quality control has been found to be effective in significantly reducing drift and in providing a continuous evaluation of spectrometer performance. An additional benefit in applying this technique has been the gradual improvement in instrument reliability with a resultant reduction in the requirement for special maintenance.

USNRDL- TR-585

A METHOD FOR DETERMINING MISSION RE-ENTRY TIMES FOR
FALLOUT-CONTAMINATED INDUSTRIAL COMPLEXES

H. Lee
9 March 1962 28 p. UNCLASSIFIED

In the event of a nuclear war, knowledge of the time of availability, after contamination by fallout, for re-entry and use of certain resources is important in planning and preparing for the nation's recovery. This study is limited to the estimation of the availability time for industrial complexes that are not physically damaged by the attack or by emergency shut-down, but are inaccessible because of radiological contamination by fallout. A method of calculation proposed to be suitable for all industrial complexes was applied to five petroleum refineries. The findings were that the dose to decontamination personnel is the primary factor limiting re-entry and use. For the standard intensity range of 100 to 30,000 r/hr and dose limits of 30 r/24 hr, 230 r/2 wk and 1,000 r/yr, the mission re-entry time for the refineries studied ranged from 1 to 35 days.

USNRDL-TR-586

A PORTABLE COMBINATION DOSE-DOSERATE METER, RDGI-1

R. L. Hopton
1 October 1962 28 p. UNCLASSIFIED

A battery-operated portable combination ratemeter-dosimeter has been developed which will measure gamma radiation rate from 0-1000 r/hr in three linear decade ranges. Simultaneously, the integrated dose may be read from a digital display whose range is 0-999.9 r. The least count on the digital register is 0.1 r. The rate may be read with an accuracy of less than ± 10 percent between -40 and $+50^{\circ}\text{C}$. The integrated dose from Co^{60} isotope may be read to 0.1 r or ± 10 percent, whichever is greater, from -40 to $+50^{\circ}\text{C}$. Battery life, using two C size nickel-cadmium rechargeable cells is in excess of 40 hr per charge. Package weight, including battery, is less than 3 lb, and size is 4 by 4 by 7 in.

USNRDL-TR-587

FLUX AND SPECTRAL MEASUREMENTS OF PRIMARY AND MODERATED NEUTRON SOURCES

E. Tochilin
8 October 1962 32 p. UNCLASSIFIED

Radioactive (α , n) neutron sources maintained by the U. S. Naval Radiological Defense Laboratory (USNRDL) include Ra-Be, PuF_4 , and four PuBe_{13} sources. Comparative neutron emission rates for these sources were determined by two separate methods. These included: (1) the manganese sulfate bath with appropriate corrections made for fast neutron escape or capture and for thermal neutron capture by the source; and (2) long counter measurements corrected for energy response and source anisotropy. Agreement to within 1 percent was obtained by the two independent methods. A Ra-Be source calibrated against the National Bureau of Standards neutron standard was used as a primary reference.

Spectral measurements of PuBe_{13} and PuF_4 neutron sources were made with nuclear emulsions. By the use of cylindrical plastic and

lead absorbers, an effort was made to moderate the PuBe_{13} spectrum and thereby obtain additional calibration points for instrument response studies. Spectral changes were initially studied with the double-moderator technique, followed by later measurements with nuclear emulsions. From flux and spectral measurements of the primary and moderated radioactive sources, the first collision tissue dose was calculated and, in turn, compared to experimental measurements of absorbed dose with proportional counters designed according to the Bragg-Gray principle.

USNRDL-TR-588

SOLUTE DISTRIBUTION IN THE Na_2O - B_2O_3 - NaCl SYSTEM

I. ALKALI METALS

M. H. Rowell

9 October 1962 23 p. UNCLASSIFIED

The distribution of trace amounts of Cs and Rb between immiscible liquid phases over a wide composition range in the system Na_2O - B_2O_3 - NaCl at 830°C was studied by means of Cs^{137} and Rb^{86} . Phase diagram data and distribution coefficients of the solutes were obtained during these equilibrations. The distribution of solutes is presented as a function of the compositions of the two conjugate phases. At low Na_2O content in the system the borate/salt distribution coefficients have the order $\text{Cs} > \text{Rb} > \text{Na}$, but at high Na_2O content the order is reversed. Other solutes such as Ca show a greater variation of distribution coefficient with phase composition than do alkali metals. An explanation of solute distribution is offered on the basis of changing borate network structure and the formation of ion exchange sites therein.

USNRDL-TR-589

A SCINTILLATION DETECTION SYSTEM FOR THE INSPECTION OF LARGE SOLID PROPELLANT ROCKET MOTORS

K. F. Sinclair and H. A. Zagorites
31 May 1962 23 p. UNCLASSIFIED

The integrity of solid propellant rocket motors is essential to their reliability. Consequently, for the motors presently used in large rockets, complete radiographic inspection is normally required. This is a costly and time consuming procedure. Future motors planned for advanced space vehicles will, however, be much larger, and satisfactory radiographic coverage with existing high-energy X-ray machines and film speeds will become impossible. Sensitive scintillation detectors and associated electronic systems in place of the film offer a possible solution to the problem. Experimental results obtained with a differential continuous scan system and a POLARIS A-2 motor have demonstrated the potential performance of this type of system and validated the theoretical performance equation. Extrapolation to motors as large as 20 feet in diameter has also shown the method to be a promising means of accomplishing this difficult testing task.

USNRDL-TR-590

SOME RADIOCHEMICAL AND PHYSICAL PROPERTIES OF NUCLEAR DEBRIS FROM DANNY BOY (U)

W. B. Lane
15 October 1962 24 p. SECRET RESTRICTED DATA

Two fallout samples were obtained from Danny Boy for radiochemical and physical properties measurements.

The specific activity was found to be nearly constant over the range of particle sizes tested. About 20 percent of the total activity was found to be associated with sub-sieve particles (less than 44 microns) and 9 percent with particles less than 1 micron in diameter. These findings must be conditioned by the fact that the samples were scooped from the frozen ground and had been subjected to rain and snow.

The analysis of the Danny Boy samples served to proof-test the methods and equipment which were subsequently used for the extensive field tests at Small Boy. (Abstract UNCLASSIFIED)

USNRDL-TR-591

PHOTOMICROGRAPHIC TECHNIQUE FOR MEASURING GRAIN
DENSITIES OF HIGHLY IONIZED PARTICLE TRACKS IN NUCLEAR
EMULSIONS

E. V. Benton
26 October 1962 22 p. UNCLASSIFIED

A technique for rapid and accurate measurement of gap lengths of nearly saturated particle tracks in nuclear emulsions is reported. The method consists of obtaining photomicrographs of particle tracks with a superimposed image of a calibrated eyepiece-micrometer disc. The gap lengths are measured to an accuracy of 1/4 micron.

USNRDL-TR-592

COMPUTER-AIDED ANALYSIS OF GAMMA-RAY SPECTROMETER
DATA

P. A. Read and F. M. Tomnovec
26 October 1962 25 p. UNCLASSIFIED

Gamma ray pulse height distributions are analyzed with the aid of a computer. The method is based on a library of standard distributions punched on IBM cards. To reduce a pulse height distribution into discrete peaks, appropriate standards are chosen from the library, and adjustment factors are provided so that the computer can fit the standards to the distribution. It removes each fit successively from the distribution and leaves us a record thereof. The removal facilitates subsequent fits. The records comprise a set of reduced distributions from which can be deduced the gamma ray spectrum of the source which gave rise to the original distribution.

USNRDL-TR-593

GAMMA RAYS OF In¹¹⁵

J. P. Hurley, R. M. Brown and C. E. Mandeville
26 October 1962 16 p. UNCLASSIFIED

The gamma-ray spectrum of In¹¹⁵ has been investigated with a scintillation spectrometer. The 1.14 MeV gamma ray is found to be emitted in (0.081 ± 0.016) percent of the disintegrations and the gamma ray at 1.41 MeV in (0.035 ± 0.007) percent of the disintegrations. The results are interpreted as showing evidence of the presence of at least two levels in the vicinity of 1.4 MeV in the level scheme of In¹¹⁵.

USNRDL-TR-594

AN IMPROVED ZINC BROMIDE SHIELDING WINDOW

W. B. Lane and M. J. Nuckolls
2 October 1962 14 p. UNCLASSIFIED

An improved zinc bromide-filled shielding window for hot cell use was designed, constructed, and performance-tested.

Bare steel surfaces under an argon atmosphere satisfactorily contained zinc bromide solution. No corrosion or deterioration of optical properties appear in a window which was installed in May 1961. This system is an improvement over the previously used painted surfaces in an air atmosphere.

USNRDL-TR-595

LATE EFFECTS OF FRACTIONATED X RADIATION IN MICE. FAILURE TO PREVENT NON-THYMIC LYMPHOMAS BY THIGH-SHIELDING

L. J. Cole and P. C. Nowell
4 November 1962 19 p. UNCLASSIFIED

Groups of female LAF₁ mice were exposed to an X-ray dose of 260 rads given in a single dose (at 11 weeks or 14 months of age) or

in 52 weekly doses of 5 rads each (started at 11 weeks of age). A group of the latter animals had one thigh shielded during the irradiation procedure.

The incidence of malignant lymphoma, of the generalized non-thymic type, was increased in both of the groups receiving fractionated doses of radiation; thigh-shielding did not inhibit leukemogenesis under these conditions. This finding suggests that the mechanisms of radiation induction of thymic and nonthymic lymphomas in mice may differ, since in the former case, shielding of hematopoietic cells reduces lymphoma incidence.

Median life span did not differ significantly among the three groups of mice irradiated at 11 weeks of age. The median life span for the mice receiving a single dose of 260 rad at 14 months of age (i. e., 28 months) was 5 months longer than that of the group receiving a single dose of 260 rads 11 weeks of age.

USNRDL- TR-596

ACCELERATED INDUCTION OF HEPATOMAS IN FAST NEUTRON IRRADIATED MICE INJECTED WITH CARBON TETRACHLORIDE

L. J. Cole and P. C. Nowell
19 November 1962 19 p. UNCLASSIFIED

Young adult (C57L x A)F₁ hybrid mice received a single whole body exposure to fission spectrum fast neutrons (165-306 rad). Subgroups of these mice then received a single subcutaneous injection of CCl₄, given either at 2, 12, 15, or 18 months post-irradiation. Control non-irradiated mice received a single injection of CCl₄. Other groups of mice were exposed to a single 500 rad dose of 250 KVP X rays. The incidence of hepatomas was markedly increased in the neutron-irradiated mice (19 percent) as compared with that in the X-irradiated mice (2 percent). In the neutron-irradiated mice injected with CCl₄, the hepatoma incidence attained a value of 51 percent, three times that in the mice irradiated with neutrons only. In addition, marked pleomorphism and atypicality of liver cell nuclei was evident in almost all of the neutron-CCl₄ mice, but was observed in only 6 of the 47 mice exposed to neutrons only. Of the small group of mice which received CCl₄ but no irradiation, and sacrificed up to 22 months later, none exhibited hepatomas or nuclear abnormalities. In this

system, therefore, CCl_4 seems to act as a promoting agent in liver carcinogenesis. These findings, taken together with other data in the literature, support the concept that hepatoma induction is accelerated as a consequence of the action of a specific proliferative stimulus on cells bearing a latent radiation-induced alteration. The general question of the role of proliferative stimuli in radiation carcinogenesis is discussed.

USNRDL-TR-597

SPLEEN COLONY FORMATION AND HEMOPOIETIC RESTORATION
IN LETHALLY X-IRRADIATED MICE AFTER INJECTION OF
ISOGENIC PERITONEAL CELLS

L. J. Cole

13 November 1962 16 p. UNCLASSIFIED

The capacity of intravenously injected cells from peritoneal fluid, peripheral blood, lymph nodes, thymus and bone marrow of mice to restore hematopoiesis in lethally X-irradiated (880 rad) isogenic recipients, was investigated. Thirty-day survival and visible colony formation in the spleen were employed as the criteria. Administration of 6×10^6 or 11×10^6 peritoneal cells, and 6.4×10^6 or 15×10^6 peripheral leucocytes afforded protection against mortality, and elicited colonies in the spleen; comparable effects were observed after injection of 1.1×10^5 marrow cells. The injection of 34×10^6 adult lymph node cells or of 9×10^6 thymus cells from newborn mice had no effect on mortality, nor did they elicit spleen colony formation. A correlation appears to exist between the capacity of isogenic cells to restore hemopoiesis in lethally irradiated mice and their ability to elicit visible colony formation in the spleen. The evidence suggests that normal peritoneal cell populations and peripheral blood leukocytes contain hemopoietic stem-cell elements, with a frequency 30 to 50 times lower than among bone marrow cells. No evidence was adduced to support the concept that normal lymphoid tissue lymphocytes give rise to hemopoietic cell lines.

USNRDL- TR- 598

A STANDARDIZATION OF THE HURST RADSAN NEUTRON
DETECTOR

A. H. Redmond and M. B. Salamon
19 November 1962 22 p. UNCLASSIFIED

Dose measurements have been made with five Radsan detectors at the same operating conditions using a 100-channel analyzer and computing dose from the pulse height distribution. The detectors responded to an 80-gram plutonium beryllium neutron source at 50 centimeters with a sensitivity about 21 percent higher than the first collision dose computed from the spectral distribution. An explanation is offered. Responses to a 2-gram similar source mounted on the detectors were correlated with the counting rate on a scaler, giving a figure for a quick check of detector condition. Both measurements gave similar ratios of dose-to-counts in a 10-minute period. A shift of spectrum threshold with detector temperature rise is described.

USNRDL- TR- 599

THERMAL DIFFUSIVITY AND HEAT CAPACITY MEASUREMENTS
AT LOW TEMPERATURES BY THE FLASH METHOD

O. Makarounis and R. J. Jenkins
19 November 1962 24 p. UNCLASSIFIED

A method for measuring heat capacity and thermal diffusivity of solid materials from -180°C to $+200^{\circ}\text{C}$ is described in this report. A high intensity short duration light pulse is absorbed in the front surface of the specimen and the resulting temperature rise of the rear surface is measured by a thermocouple, displayed on an oscilloscope and photographed by a Polaroid Land camera. From the shape and magnitude of the temperature traces thus obtained, the thermal diffusivity and heat capacity of the specimen are determined. Thermal properties of aluminum alloy No. 2024 and single crystal magnesium oxide were determined with this method over the temperature range from -180°C to $+200^{\circ}\text{C}$.

USNRDL- TR-601

A SYSTEM FOR RAPID HANDLING OF AN IRRADIATED SOLUTION

A. E. Greendale and D. L. Love
13 November 1962 15 p. UNCLASSIFIED

An apparatus has been constructed for rapidly transferring irradiated solutions to a container for fast radiochemical separations. A "rabbit" containing a solution is irradiated; within 1 second after irradiation it is transported through a pneumatic system to a receiver; there it impales itself onto two hypodermic needles connected to a container under vacuum. The irradiated solution and one acid wash of the rabbit are quantitatively transferred to the container within 2 seconds. Since the system is completely contained, there is no contamination of the laboratory area nor danger to personnel.

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*See Preface for explanation of NSA and ACR.

USNRDL**TR No.****NSA*****ACR***

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